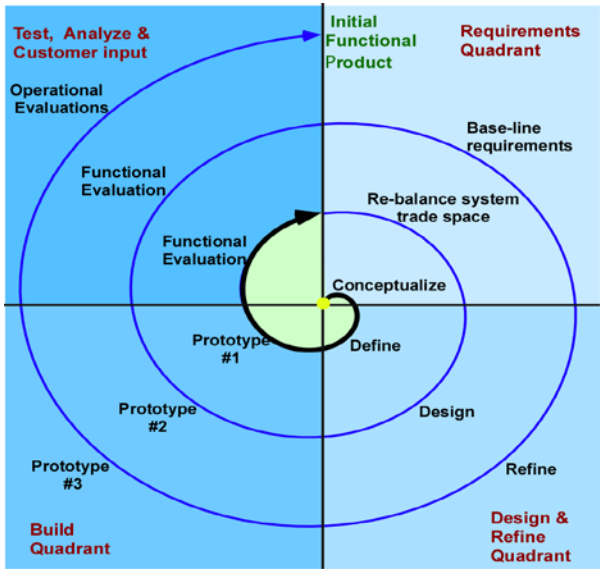
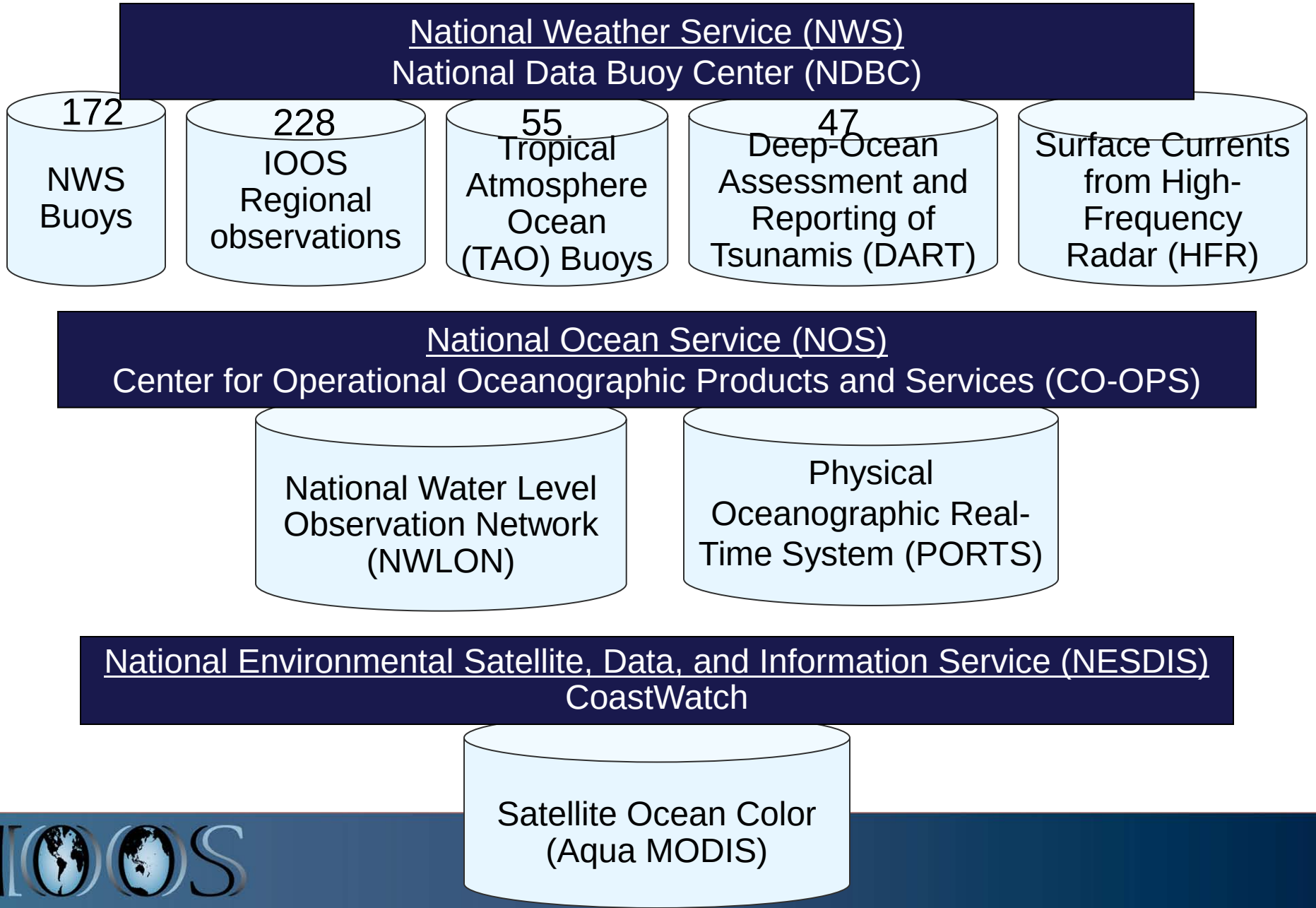
Data Integration Framework (DIF)

- **Began as pilot project (2007-2010)**
  - First spiral of IOOS data management development
  - Evaluate in FY 2010
- **Limited scope for reduced risk**
  - 3 data providers and 4 customers
  - 7 core variables
    - Currents, Temperature, Salinity, Water Level, Winds, Waves, Ocean Color (chlorophyll)
- **See http://ioos.gov/dif/ for:**
  - Links to data access services
  - SOS schema and software
  - Systems engineering documents



(Graphic by i3 Aerospace Technologies Pty Ltd – used with permission)

IOOS DIF Project Data Providers

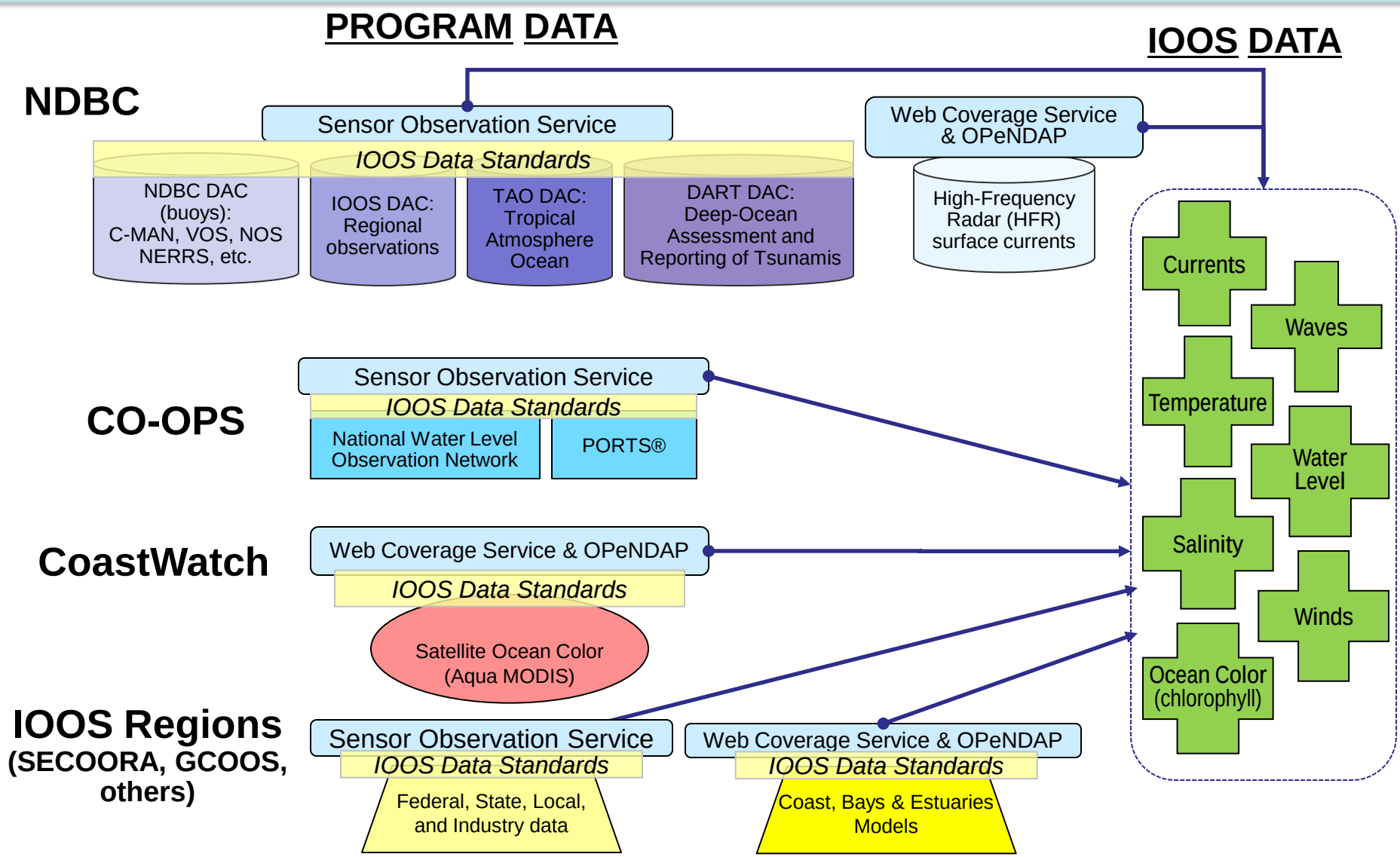


Recommended Web Services and Data Encodings

Data Type	Web Service	Encoding
In-situ data (buoys, piers, towed sensors)	OGC Sensor Observation Service (SOS)	XML based on OGC Observations and Measurements (O&M)
Gridded data (model outputs, satellite)	OpenDAP and/or OGC Web Coverage Service (WCS)	NetCDF using Climate and Forecast (CF) conventions
Images of data	OGC Web Map Service (WMS)	GeoTIFF, PNG etc. -possibly with standardized styles

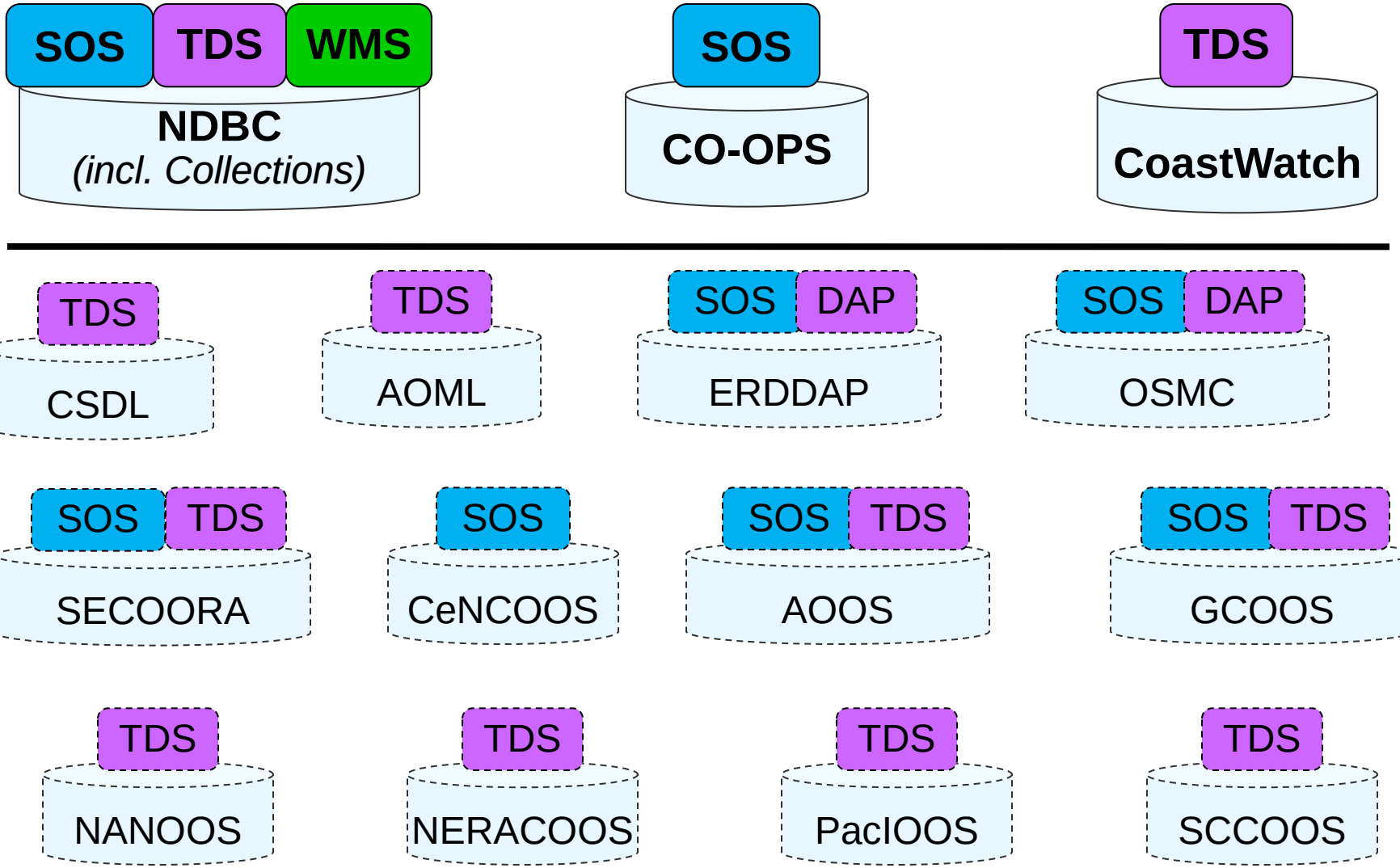
*[*OGC = Open Geospatial Consortium]*

Data Provider Implementations



Data Provider Status

Note: TDS = OpenDAP+WCS



Summary

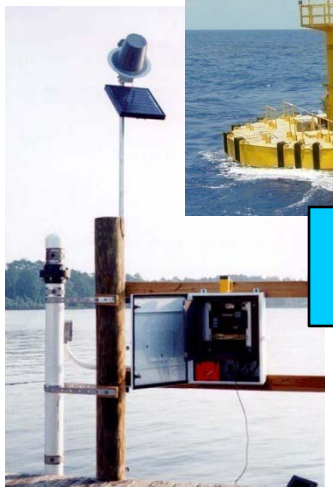
- **Standardized data access services implemented at operational data providers**
  - SOS: Point, Profile, Time Series, Collections
  - OpenDAP/WCS: Regular Grids
- **Implementing detailed metadata for sensors, platforms, systems**
- **SOS, WMS, WCS submitted as IOOS standards**
  - Need to document SOS Profile for ocean observations
- ***In planning: Expansion of DIF towards IOOS***
  - *Service types (Registry, Catalog, …)*
  - *Data types (trajectory, unstructured grid, imagery)*
  - *Data providers, data customers*

See http://ioos.gov/dif/

Backup Slides

SOS for *in situ* Observations

Sensor Systems



Observations

Quality Control

Metadata

Data Provider

SOS (Sensor Observation Service)

Capabilties XML

Table of Contents

Obs. & Meas. (O&M) XML

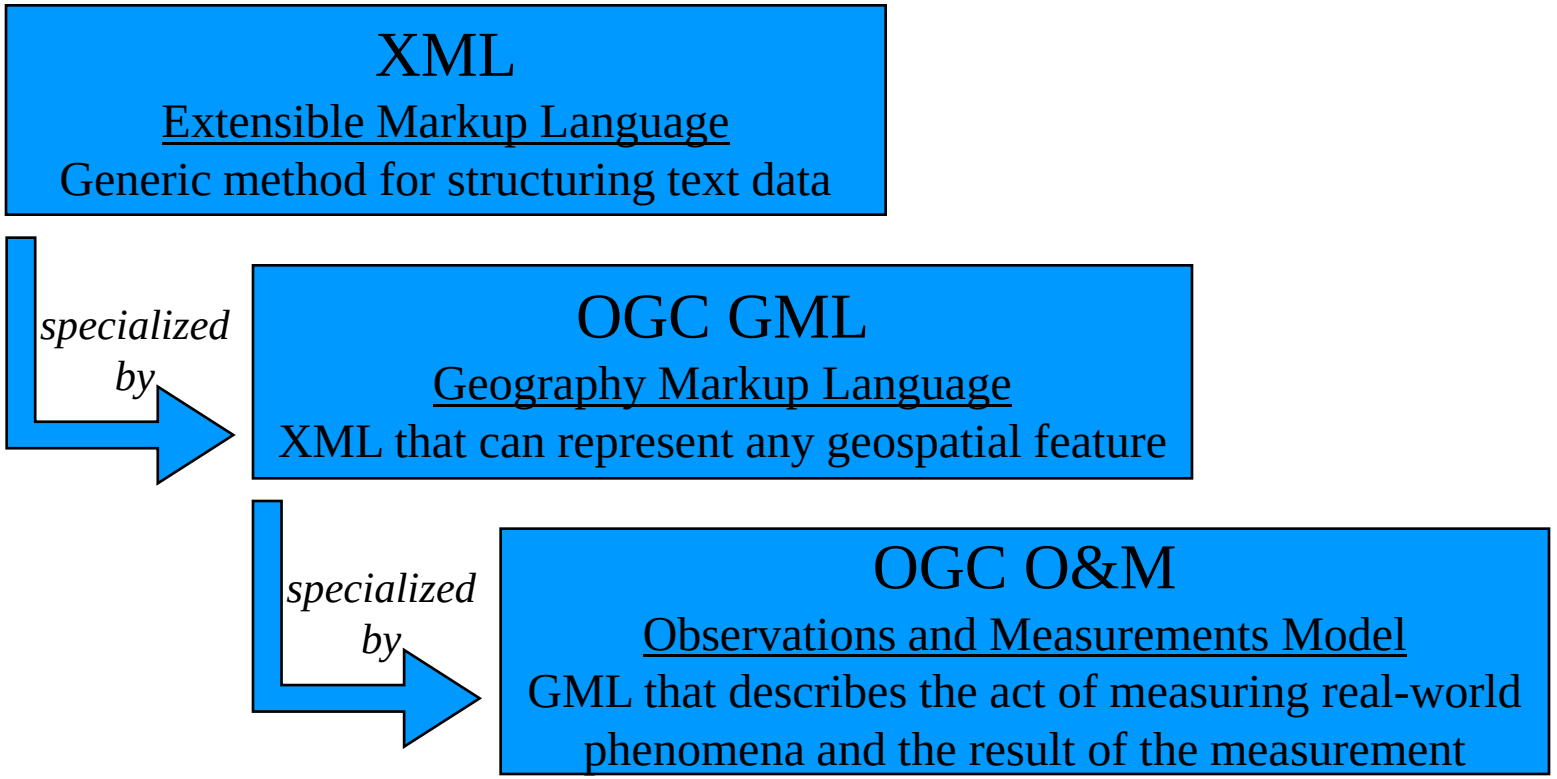
Data Values

Procedure Metadata

SensorML

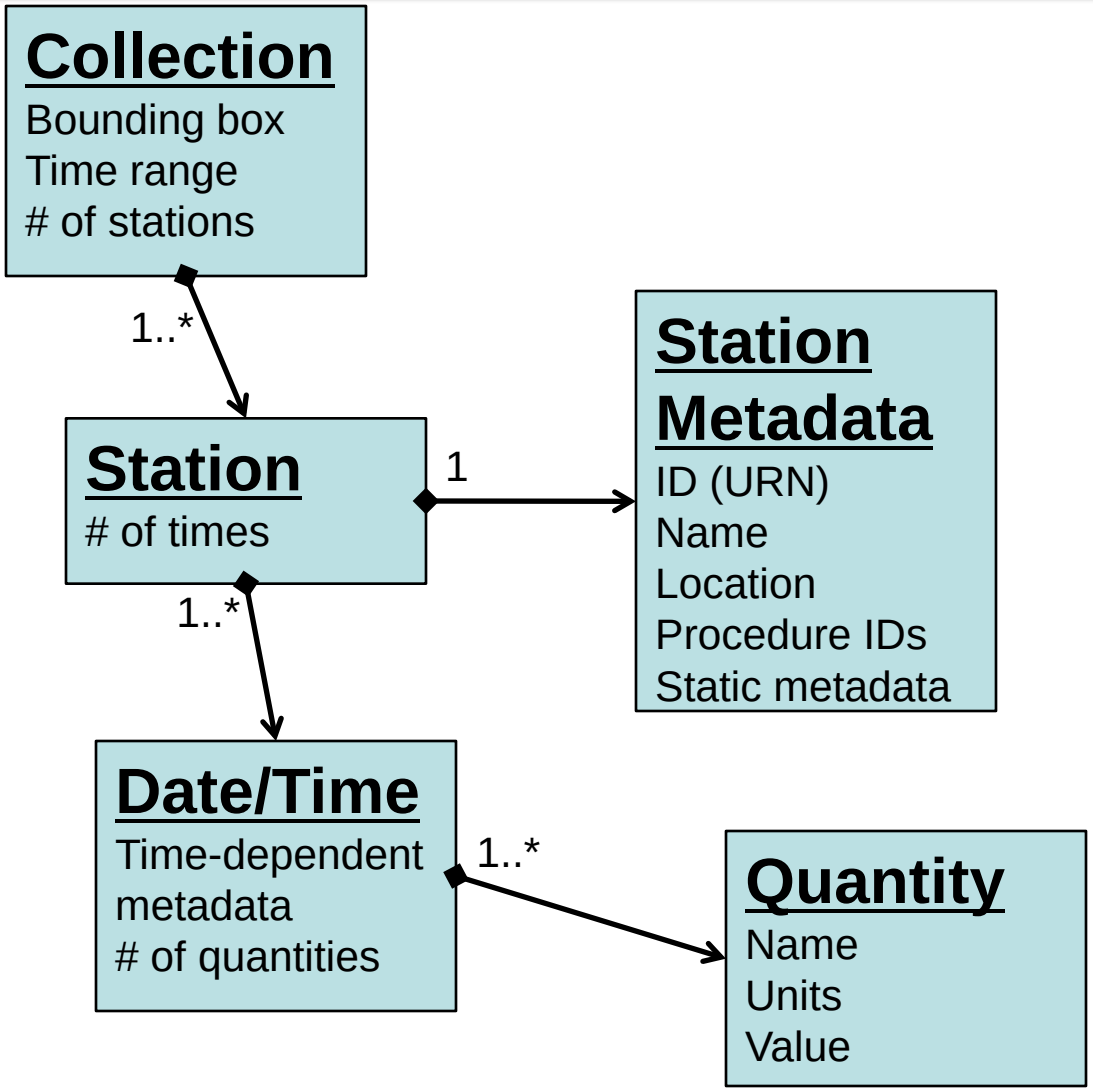
SOS GetObservation Response

XML Encoding of In-Situ Data

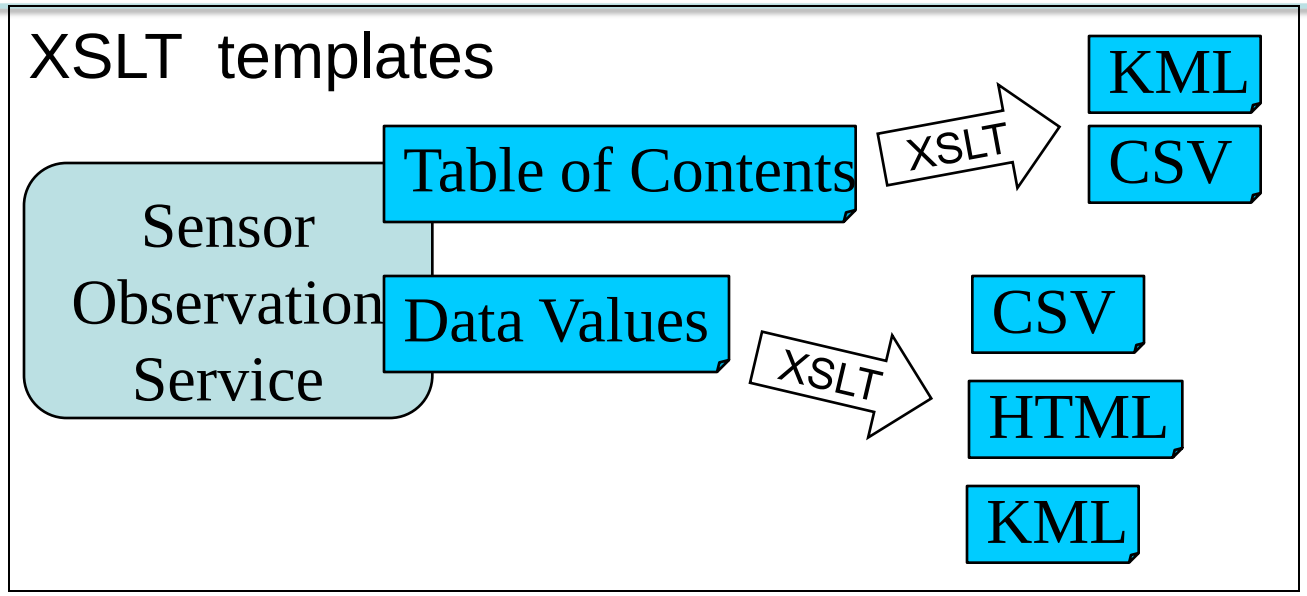


IOOS Data Model for Time Series at a Collection of Points

- **Collection**
  - Station 1
    - Time 1
      - quantity 1
      - quantity 2
    - Time 2
      - quantity 1
      - quantity 2
  - Station 2
    - Time 1
      - quantity 1
      - quantity 2
    - Time 2
      - quantity 1
      - quantity 2

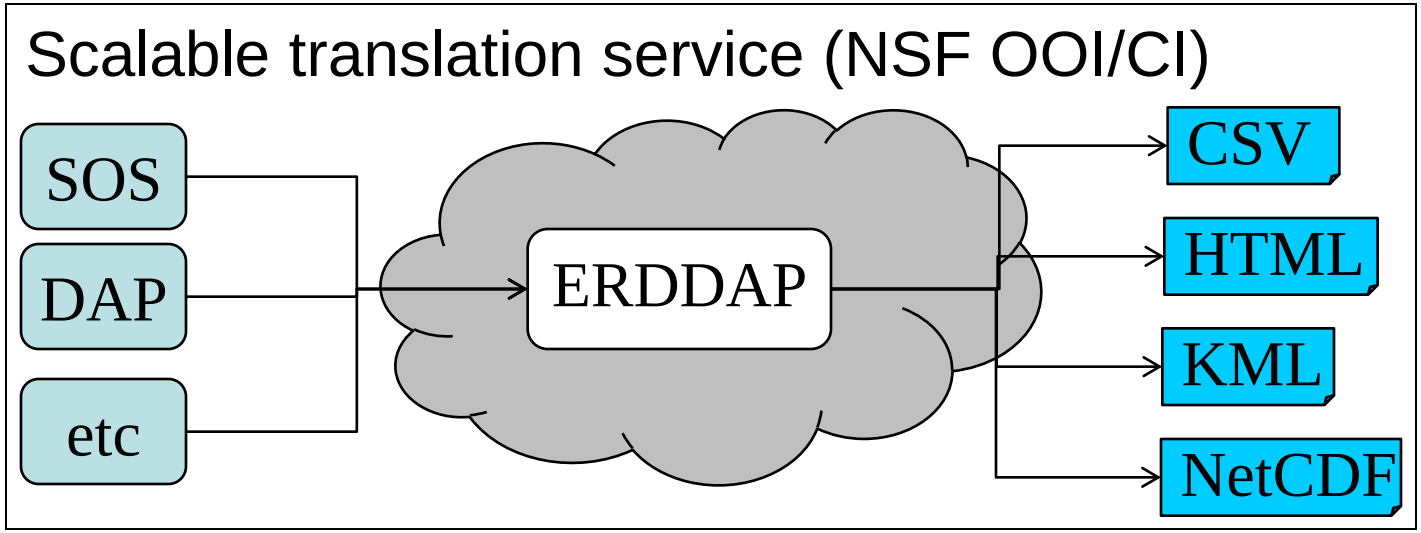


Format Conversion Tools



Spreadsheet

Browser

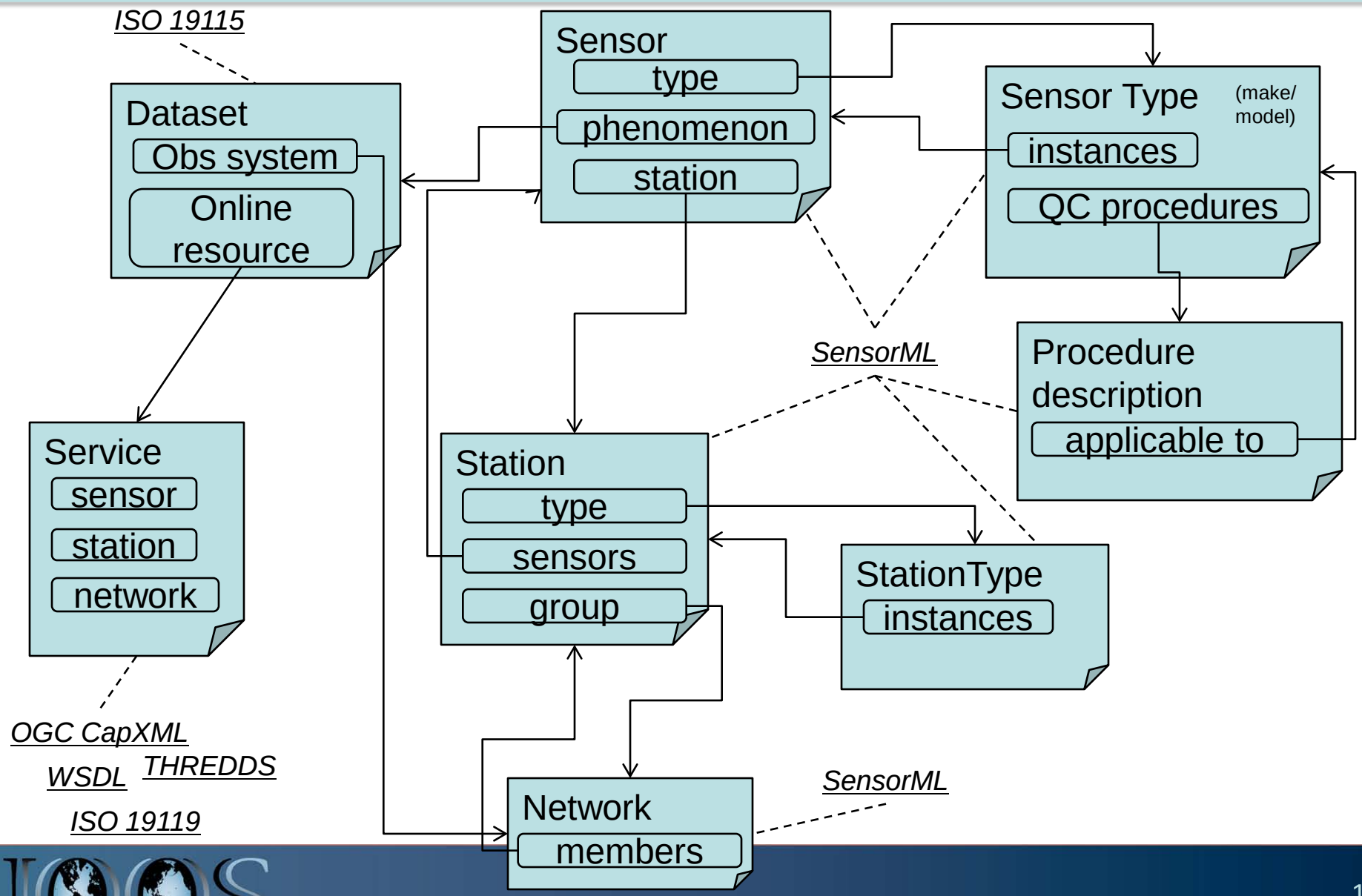


Virtual Globe

Science App

IOOS Metadata Linkage Model

(Sensors, Stations, Networks, Datasets and Services)



SOS Profile/Best Practices

- **SOS and O&M specs are fairly general**
  - Need community specialization/restriction
- **IOOS adopting, defining or researching practices:**
  - O&M schema
  - KML+JSON (Javascript Object Notation)
  - URIs for sensors, stations, networks, CRS, phenomenon names
  - HTTP GET request encoding
  - SensorML metadata
  - Observation Offerings

IOOS Practice: Observation Offerings

- **Each station (buoy, fixed sensor package) is a separate Offering from the SOS**
  - Allows requests for data from 1 station at a time
- **Multi-station Offerings:**
  - "All stations" Offering
    - User specifies bounding box instead of station ID
  - Soon: program-specific or **event-specific Offerings**
    - E.g., "all Hurricane Katrina data"
  - Maybe: phenomenon-specific Offerings
    - E.g., "all temperature data"
- **Offering includes ID and English name**
  - gml:name = ID
  - gml:description = name
- **May replace multiple sensor IDs per offering with single station ID**

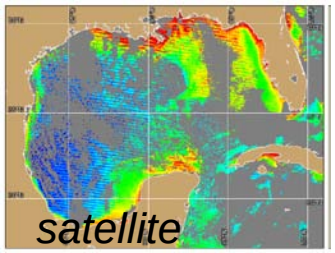
IOOS Practice: Identifiers

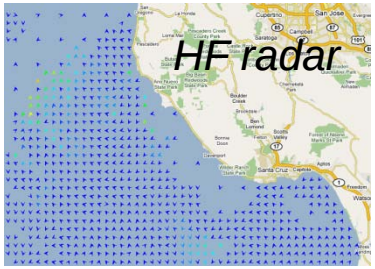
- **Using URNs for IDs of sensors, stations, networks *(URN = Uniform Resource Name)***
- **Following "OGC Definition URN" practice**
- **Examples:**
  - urn:x-noaa:def:network:noaa.nws.ndbc::all
  - urn:x-noaa:def:station:noaa.nws.ndbc::21418
  - urn:x-noaa:def:sensor:noaa.nws.ndbc::21418:tsunameter0
- **Also using URNs for EPGS CRS identifiers**
- **Using URLs for phenomenon names**
  - Adopting MMI/CF URLs: http://mmisw.org/ont/cf/parameter/sea_water_temperature
  - Allow trailing component as abbreviation (sea_water_temperature)

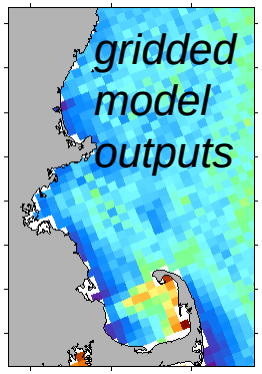
IOOS Practice: GetObservation Request

- **Supporting both HTTP POST requests and HTTP GET**
  - HTTP POST defined in spec, GET left out
  - Mostly following Oceans IE Best Practice for GET
    - For Bounding Box, using FOI that could be a BBOX or (in future) a named FOI: featureofinterest=BBOX:minlon,minlat,maxlon,maxlat

WCS and/or OpenDAP for Gridded Data and Model Outputs







Quality Control

Metadata

Data Provider

OpenDAP

WCS (Web Coverage Service)

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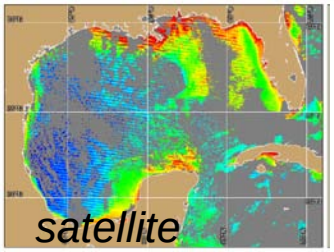
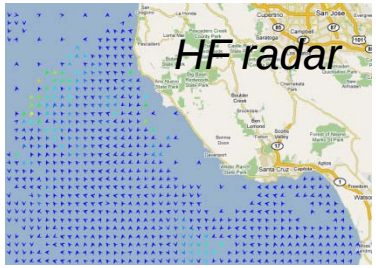
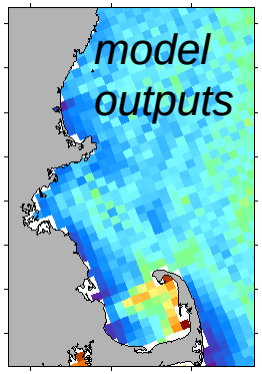
Data Values

Metadata

WMS for Maps of Data







In situ observations

Data Provider

WMS (Web Map Service)

Capabilties XML

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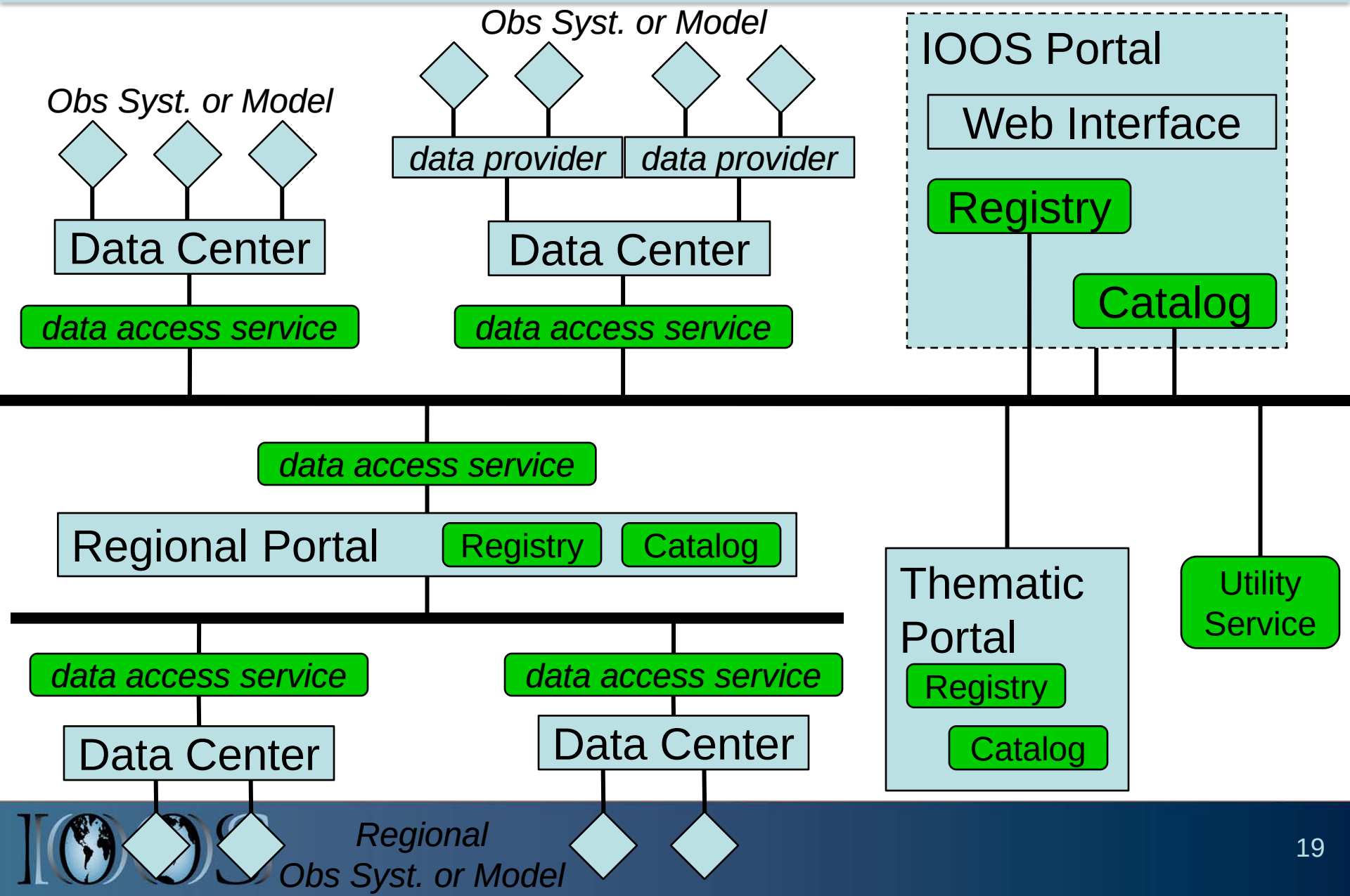
Georeferenced Images

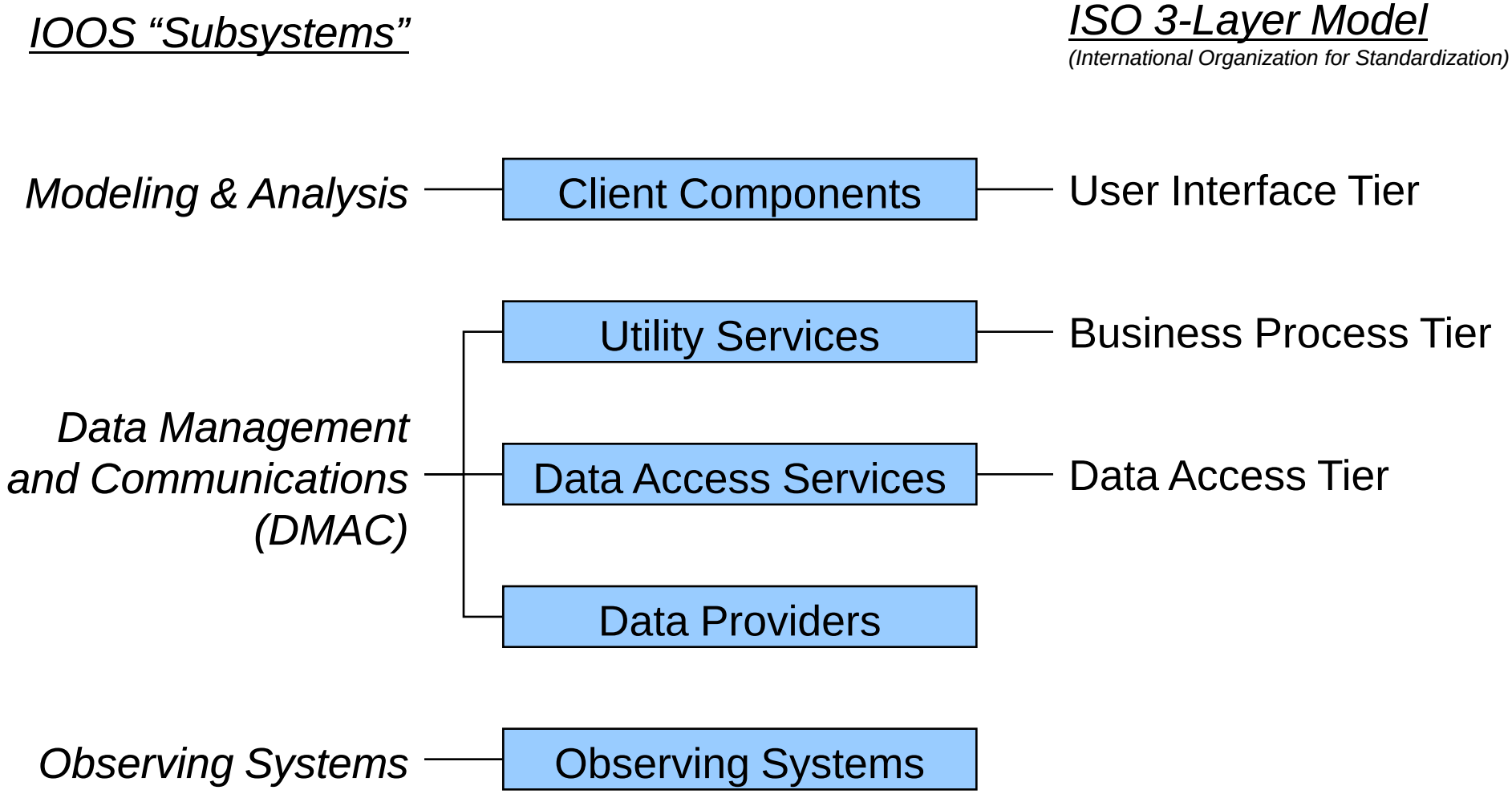
PNG, GIF, TIFF, JPEG

Federated, Service-Oriented Architecture



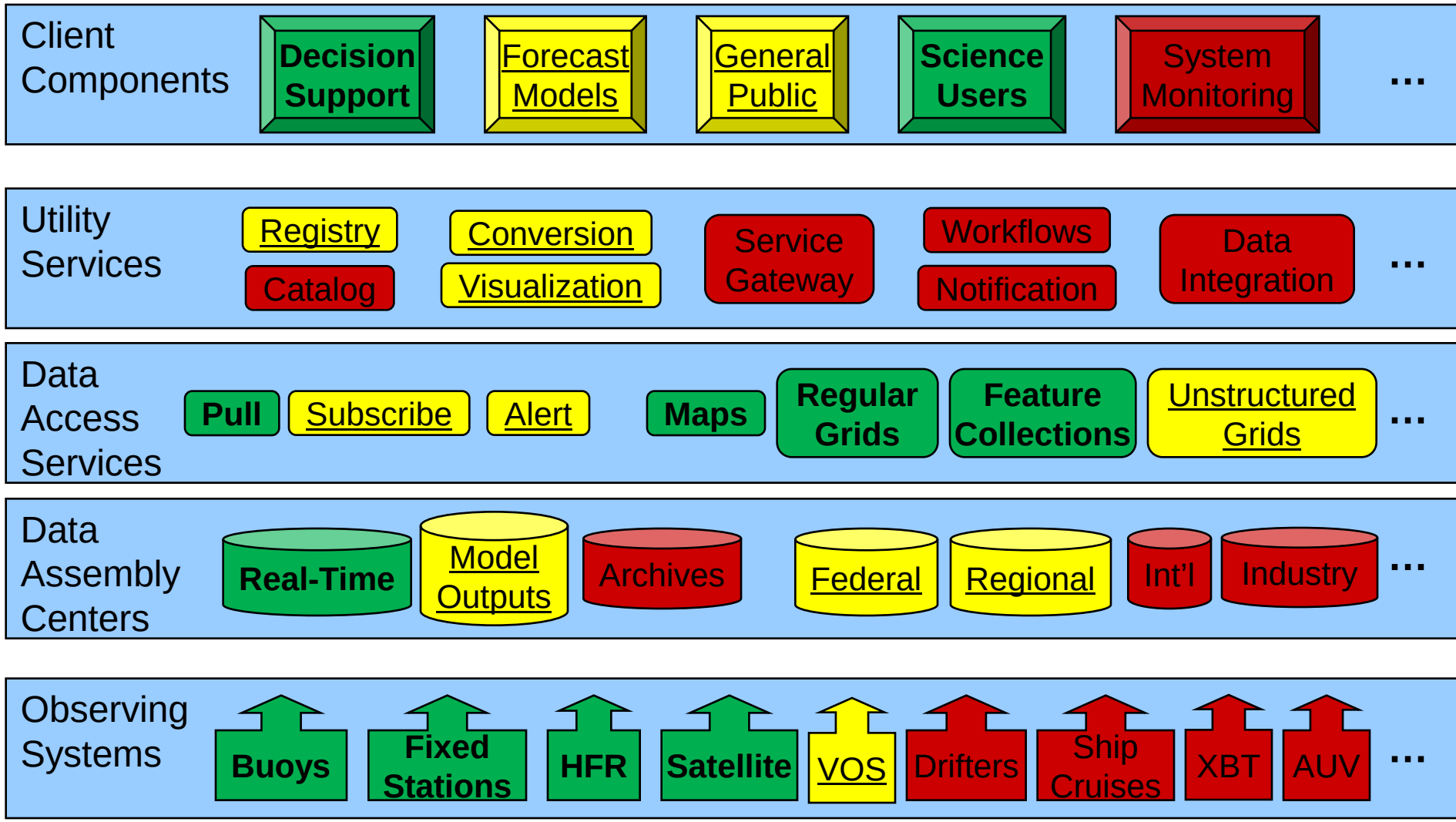
IOOS Architectural Layers

and Relationship to IOOS "Subsystems" and ISO Model



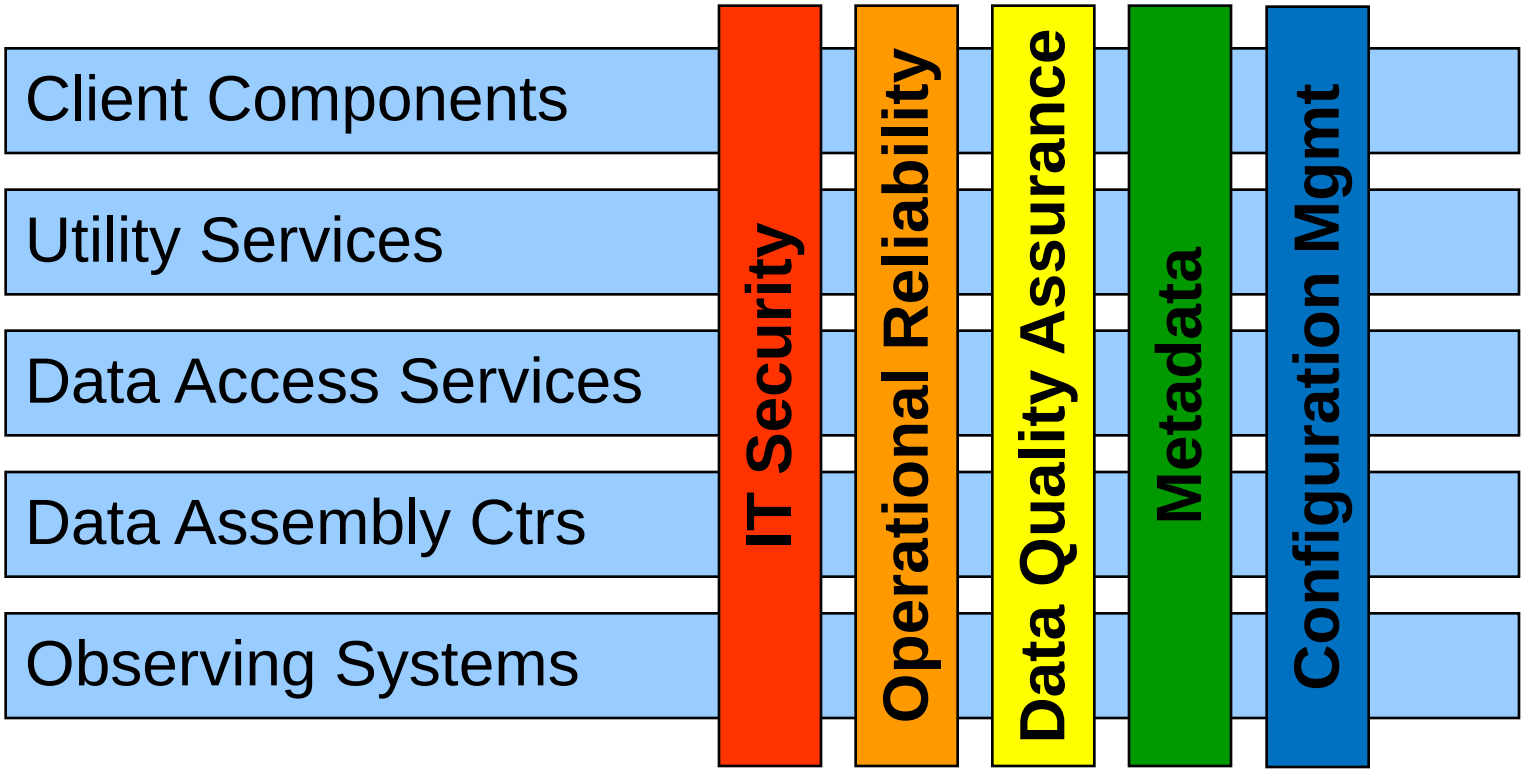
Component Types Needed for IOOS

Computational Viewpoint from Reference Model for Open Distributed Processing (RM-ODP)



Legend: ***Working examples*** | *Starting/ partial* | *Not yet addressed*

Crosscutting Concerns



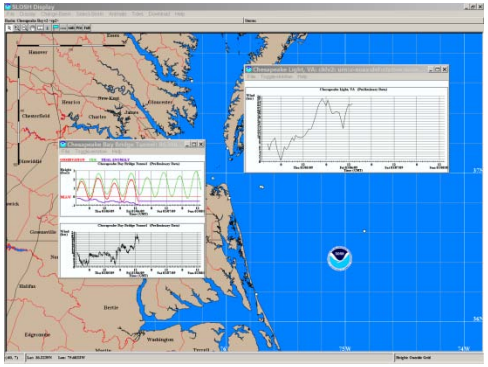
IOOS Data and Metadata Types

Information Viewpoint from Reference Model for Open Distributed Processing (RM-ODP)

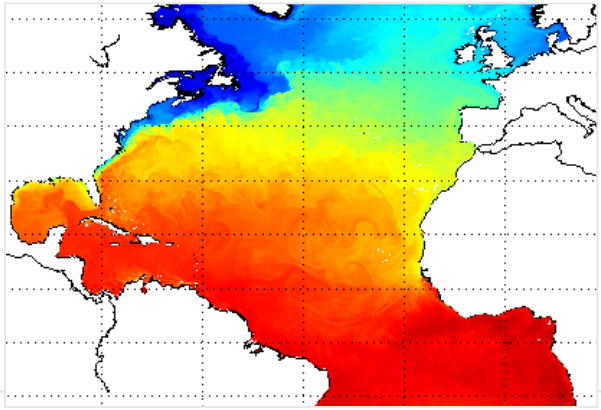
Service Metadata	(**OWS Capabilities XML**, ISO 19119)
Discovery Metadata	(FGDC, ISO 19115/19139)
Controlled Vocabularies	(CF, MMI, **OGC**, GCMD, **URNs**)
QA/QC Metadata	(QARTODS/Q20)
Sensor/Platform Metadata	(SensorML)
Data Encoding Conventions	(**GML**, KML, O&M, SWEC, CSML, **NetCDF/CF**)
Collection Types	(**Time Series**, **Multi-Station Obs**)
Sampling Feature Types	(**Point**, **Profile**, Trajectory, **Reg Grid**, Unstructured Grid)
Ocean Properties	(**Temperature**, **Salinity**, **Currents**, **Waves**, **Chlorophyll**,

IOOS DIF Customer Projects

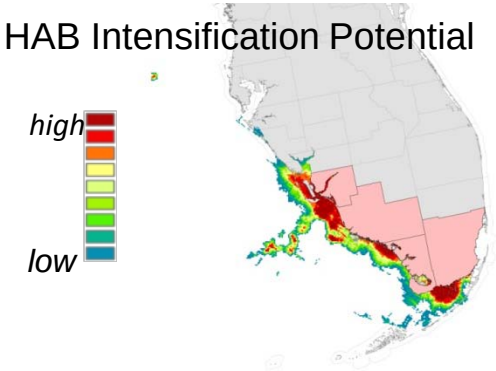
Coastal Inundation: Sea, Lake and Overland Surge from Hurricanes (SLOSH) model



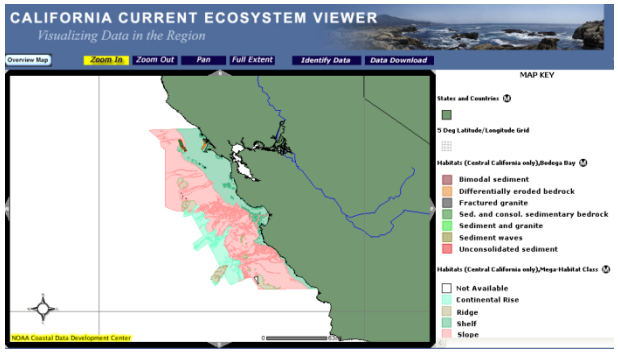
Hurricane Intensity: Real-Time Ocean Forecast System (RTOFS-Atlantic)



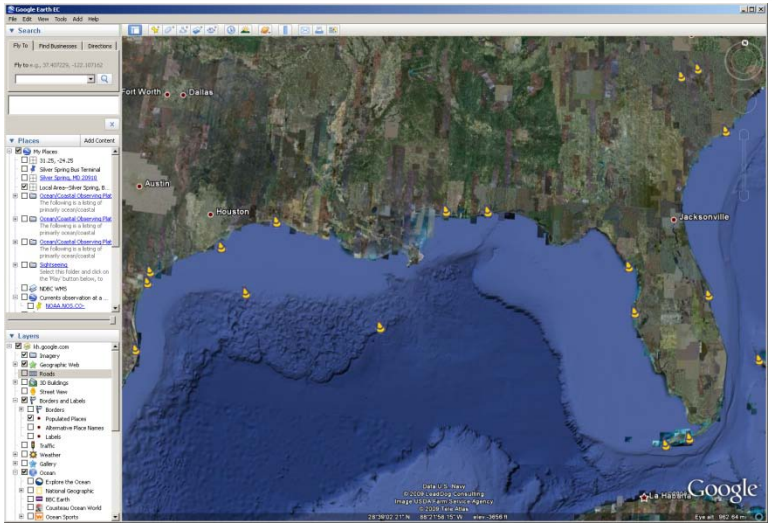
Harmful Algal Blooms: HAB Forecast System (HAB-FS)



Integrated Ecosystem Assessments: Environmental Research Division Data Access Protocol (ERDDAP) application



Additional IOOS DIF Customers *(in progress)*

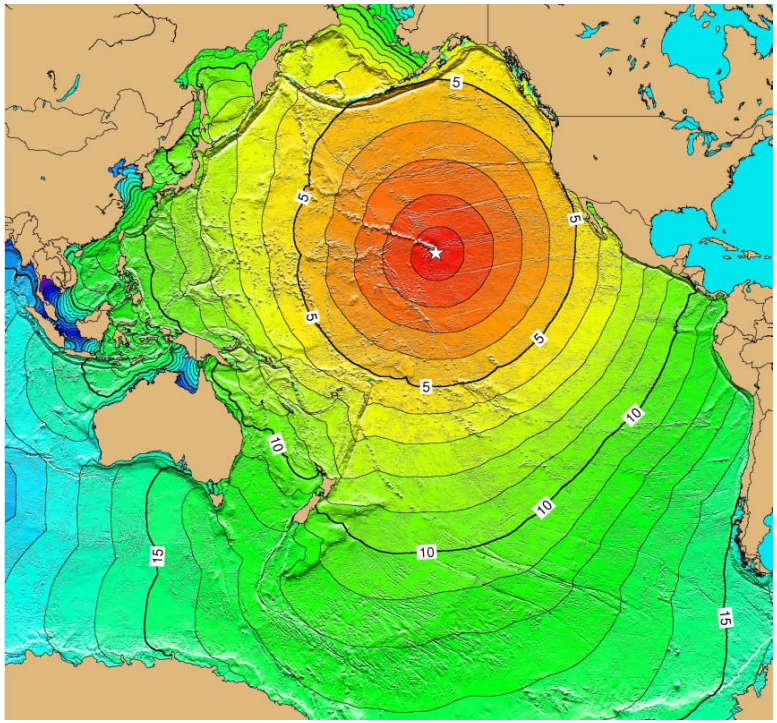


Screenshot of Google Earth

Google: Standardized access to observations for Google Oceans

- Exploring KML+JSON

Tsunami scientists: Prepackaged collections of event-specific observations from DART buoys



Travel time map for November 29, 1975 tsunami in Hawaii (NOAA NGDC).